Know-how Transfer Methodologies within Outsourced Processes and Global Production Flow

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Abstract

Global production processes over the last few years heavily deploy outsourcing, often across borders, thus introducing the concept of the virtual, modular enterprise; production steps may be executed by independent service providers and often involve the participation of SMEs. This trend is especially evident in the manufacturing sector, in which outsourcing production cycles are worth 150b Euros worldwide. Furthermore, after the EU expansion outsourcing in the European manufacturing sector often involves companies in the new member states, providing an important economic development vehicle. Despite the economic benefits it involves, outsourcing introduces new requirements in terms of skill development and know-how transfer from the outsourcer to the client aiming at quality assurance and interoperability of distributed production processes. While standardization facilitates harmonization of skills in the formal VET training system, outsourcing often involves transfer of on-the-job knowledge in informal settings. Skill development requirements in the context of distributed process management may not be adequately met by traditional training methods that involve face-to-face demonstration followed by hands on practice. This paper reports work in progress targeting new methodologies for skill development in global production contexts that fully exploit the advances in virtual communications and networking technology. It utilizes video communication to improve communication; facilitate semantic interoperability in multilingual and multicultural production environments, and skill development-related costs.

Keywords: outsourcing, methodologies, production, global, accreditation, training, know-how, quality assurance, certification, standards, video

Introduction

Outsourcing has enabled companies in Europe to turn around their processes and reinforce their competitiveness in the world markets.

Outsourcing has allowed companies to become more modular: entire departments or processes may be managed by 3rd parties acting as virtual subsidiaries.

However, the outsourcing cycle is far from efficient and inter-company quality assurance processes still introduce challenges. This gap in the outsourcing industry is being partly addressed through EU directives, harmonized standards, and educational guidelines aiming at smooth cooperation; these standards promote new production systems where outsourcing of knowledge-based production is frequently used as a necessary process. While these measures are a step in the right direction, know-how transfer in the context of quality assurance of outsourced processes is still not properly addressed within management of the distributed virtual subsidiaries. The result is a steady increase of expensive product recalls that effectively slow down the modernization of industrial production systems and technologies.

This observation is especially evident in the European manufacturing industry, which is the 2nd largest sector in the extensive use of outsourcing covering 150b Euros worth of contracts worldwide. In this environment, companies do not only sell products, but also know how and processes; large companies need to transfer their internally developed know how to SMEs that are recipients of outsourcing contracts.

The regulated European manufacturing industry enhances a new market for trans-national on the job know-how competence transfer where effective, possibly remotely located in-company skills upgrading processes and mentoring/tutoring solutions constitute critical business activities within successful production frameworks.

This paper presents new competence transfer models and skill development principles for organising, delivering, and deploying effective production technology transfer intra- and inter-company, as well as towards VET schools. The paper presents work in progress for establishing new models for delivering in-company skills development processes that significantly reduce the costs related to technology transfer and enhances production competence transfer. The proposed framework extends the existing formalised vocational training system, and the informal transfer of know-how usually practiced in companies through an innovative combination of virtual blended learning environments. This environment utilizes educational video content delivery, state of the art principles for learning design and learning activities, and coordinated active feedback of knowledge exchange for peer-to-peer corrective actions in direct production through videoconferencing/video streaming technologies.

The emergence of outsourcing and the “virtual, modular enterprise”

Outsourcing of production has nearly taken place as long as the industry has existed. The background for the outsourcing can vary, from pure cost/benefit reasons, time to market considerations or other strategic interest considerations.

Whatever is the cause for the outsourcing, some general problems may occur depending of what type of outsourcing we deal width and the technological complexity of the product to be outsourced.

"Outsourcing" involves transferring or sharing management control and/or decision-making of a business function to an outside supplier, which involves a degree of two-way information exchange, coordination

and trust between the outsourcer and its client. Such a relationship between economic entities is qualitatively different than traditional relationships between buyer and seller of services in that the involved economic entities in an "outsourcing" relationship dynamically integrate and share management control of the labour process rather than enter in contracting relationships where both entities remain separate in the coordination of the production of goods and services. Many companies outsource manufacturing and engineering.

It is apparent that many organisations today are making the decision to outsource. In today's global marketplace outsourcing has made itself accessible to many organisations on a National and International level. Outsourcing has provided many businesses with the opportunity to harvest the benefits of lower labour costs and to exploit the value of less than par foreign currencies. Through outsourcing, companies today have the ability to develop competitive strategies that will leverage their financial positions in the ever competitive global marketplace. Outsourcing may also be successful in increasing product quality and/or substantially lowering firm and consumer costs (e.g., increases the quality to cost ratio). Because outsourcing allows for lower costs, even if quality reduces slightly or not at all, productivity increases, which benefits the economy in aggregate.

Some of the major advantages that today's organisations can expect to obtain through outsourcing include the ability to purchase intellectual capital, to focus on core competencies, to better anticipate future costs, to lower costs. Overall outsourcing is viewed by many organisations as a strong business tactic that ultimately is a superior economical approach to developing products and services.

Outsourcing extends the traditional view of enterprises. It introduces the concept of the virtual and modular enterprise where production process steps are executed often in a distributed manner which may involve partners across borders.

Outsourcing cultures and emerging skill development requirements

Today's global competitive business environment has made the culture of an organization a critical aspect of its success (Sadri 2001). Culture is commonly identified as "a set of mores, values, attitudes, beliefs, and meanings that are shared by the members of a group or organisation", and is often the primary way in which one 'group' (organisation, team, etc) differentiates itself from others (Williams 1993, Duarte 2001). Unfortunately, little attention is paid to the practical, day-to-day process involved in creating, managing and changing culture (Williams 1993). Every organization within the industry has its own unique culture, sub-culture, character, nature, and identity. It has its own history of success and failures, which reinforces or challenges the organization's 'way of doing things'. Older and more successful organizations, for example, are said to have stronger cultures, natures, and identity (Meudell 1994, Schneider 2000). Yet, despite the growing awareness of various cultural issues, little attention is paid to the practical, day-to-day process involved in creating, managing and changing culture (Williams 1993).

The distributed nature of the production process introduces advanced needs in terms of know-how transfer in an international environment. Processes must be harmonized and standards must be followed. The above are easier to comply with in the context of formal training. However,

outsourcing involves the transfer of on-the-job developed know-how from one company to another for the execution of specific tasks the outputs of which must be interoperable in a wider production chain.

Traditionally, outsourcing challenges involve cost control. The relationship with a company and outsourcer can be extremely tense if the expectations of performance differ between the outsourcer and the client. Fortunately this is a topic that can be addressed by the client. To avoid this it's critical to invest in the required time and other resources for skill development upfront as well as to select a partner that has both the capability and the motivation to achieve objectives

Skill development design must also address the need for a certain level of integration between the company and outsourcer's operations to keep communications strong, expectations met, and best practices shared. It is important to create a relationship that allows for ongoing dialogue to occur with several levels of the in-house team. Although outsourcing is less resource intensive than managing it internally in the long run, it does require assigning resource internally to streamline communication channels as well as skills.

On the other hand, the manufacturing industry culture may vary significantly across cooperating companies. These cultural differences may cause cooperation problems that are likely to appear over time and it may be difficult to observe it in the very beginning of the cooperation.

The above introduce the issue of "semantic interoperability" in the context of global production processes. Engineers in the manufacturing sector often point out the issue of using the same words to describe different processes, even at a time where significant efforts are made towards standardization. This may be especially accentuated across borders and continents where standards may vary.

Manufacturing is a sector in which know-how is typically transferred through demonstration. While this model works well intra-company, it may be challenged by obstacles introduced by the simple fact of distributed production within global production processes. Simple text-based presentations cannot replace face-to-face instruction and the use of static images may still fall short of meeting communications requirements. Engineers typically complain that concepts must be communicated by faxing demonstrative images, with the original being returned full of notes and questions. Thus, skill development and communication in a distributed production process requires know-how transfer methodologies that overcome the shortcomings of traditional methods.

Formal and informal know-how transfer methodologies in global production flow

Activities Based Training methods towards skill development in the context of production processes

Traditional training methodologies in the manufacturing sector frequently require that students follow theoretical instruction followed by hands-on training and welding practices.

Our research focuses on the deployment of Activity-Based Training (ATB) methodologies for in order to improve skill development in fabrication. ABT applies training closely connected to the actual production activities as these are defined through work packages with

the production path of a predefined process or product. The training content becomes available at the time needed in a manner that allows the learner to proceed through a logical sequence of training elements. Various training delivery technologies may be used in combination with ABT to create a more engaging and motivating educational environment. The learner can access educational content delivered as learning objects in varying media formats, possibly through learning management systems.

The following figure displays the logical steps of a training activity for a specific process, organized through the ABT paradigm.

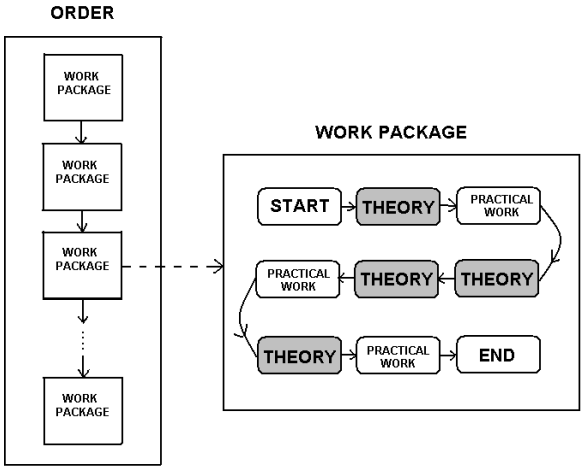

Figure 1. A mechanical industry order contains a number of work packages.

As shown in figure 1, the course utilizes work orders. An order is divided into several logical elements (work packages), which follow the fabrication and production process. A work package is comprised of a series of learning elements, which can follow independent learning design. They may involve pure theory or combine it with hands-on training. The example revolves around harmonized contents as these are defined in the document IIW IAB-089-2003/EWF-452-467-480-481, the Guideline for the International Welder Education by the European Welding Federation and creates a framework for harmonized education in Europe as well as internationally. Third party verification performed either by the teacher or by other learners follows practical training to facilitate validation of outputs and raise responsibility awareness among learners.

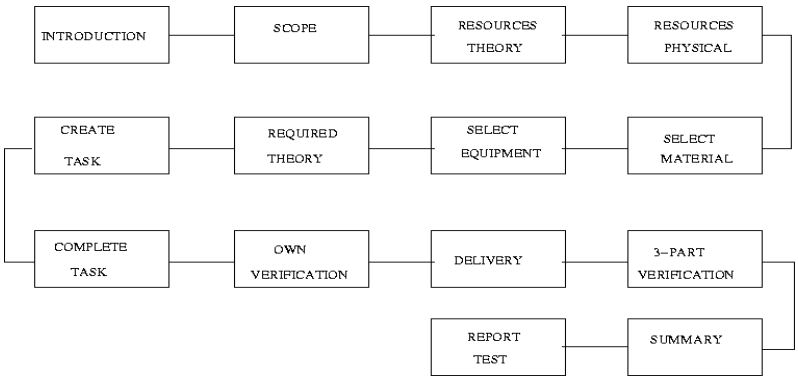

Figure 2. The general design of one course module within the ABT methodology

Figure 2 displays the general design of a course module based on the ABT paradigm. During the course the teacher presents the students with new tasks which are structured as work packages, in order to adapt to the natural production workflow. Students may be assigned different roles in this scenario, with responsibility for different actions. The training can be delivered either as on-site training where the teacher uses the course modules in classroom training, or partly as a distance-learning course. In the latter approach, the students access training, education and learning material through extended blended learning training environments using Internet, various e-learning technologies, as well as state of the art visual communication and collaboration technologies.

Blended Learning towards inter- and intra-company training delivery

It is expected that learners participate in skill development programs while working in the industry. For this reason, the training delivery method must take into account limitations in terms of time and location. It should further be noted that in a professional environment learners can benefit from each other's knowledge and skills, as much as through the interaction with an instructor. Thus, the social part of education becomes an increasingly important factor.

For the above reasons, we proposed Blended Learning training delivery methodologies that deploy a combination of channels for know-how transfer, and specifically:

- In-class formal instruction
- Visual technologies-based distance communication
- Hands-on practical training
- Self-paced learning

In-class instruction is ideal for theoretical, standards-based education and has the best results when combined with hands-on practice under in real-life conditions focusing on specific jobs, tasks, processes and materials under the supervision of an expert. Self-pace learning allows the retrieval of information from a library of learning objects or from sequences of training modules in a more general course structure. Sequences may be short sub-courses, or course elements within a smaller domain.

It should be noted that face-time (that part of the training where the instructor and the students may use oral communication) is very important for information exchange among professionals. Taking this into account, visual communications technologies can significantly increase face-time and complement in-class instruction as a know-how sharing tool facilitating both formal and informal knowledge sharing. The importance of visual communications tools and their integration into ABT and Blended Learning practices will be further detailed in the sections below.

Blended Learning delivery of ABT-based educational content has the following advantages:

- It allows the control of training related costs, both in terms of travel expenses and in terms of time off-work. The latter includes the disruption to the work schedule pre and after training related travel, as well as the disruption to the lives of professionals as it usually takes a few days to get into the normal work rhythm

- The increased face-time and the limited use of self-paced learning in the context of a wider skill development strategy is a step forward from traditional distance teaching, which is not applicable in industrial processes and which suffers from a reputation of lower quality as compared to in-class instruction
- It allows training to take place intra- and inter-company, often across borders, in the context of a global economy

Visual communications technology in professional skill development

Visual learning and media rich educational content

Perceptual modality is a key consideration in learning design. It relates to the delivery method under which a learner best comprehends and absorbs knowledge. Individuals may learn more effectively through visual presentations, audio presentations, through reading texts I a self-paced manner, or combinations of the above.

In a manufacturing environment where training revolves around specific processes and tasks typically demonstrated by an expert in real-life conditions, visual presentations provide a vivid means for know-how transfer. Pictures, images and video help learners understand concepts and implementation steps better than oral explanations. Literature has not always succeeded in providing explicit or decisive conclusions with relation to the impact that multimedia technology has on learning. Until recently (Samaras, 2006) it failed to recognize a broader range of parameters like the knowledge level of the learner, the intrinsic cognitive load, support from the multimedia learning environment and cognitive processes encouraged of learners by the environment.

The theoretical and practical training must merge such factors, together with a production oriented process workflow approach where the pedagogical methods are closely connected to practical fabrication activities according to the production path of a predefined structure. The theoretical training must contain a mixture of text based learning resources, and video clips in streaming video format or DVD (Stav, 2006 a and b) demonstrating various types of practices within mechanical industry:

- Laboratory type videos showing reproducing best practices in production process and/or provide solutions to problems arising during the execution of specific tasks
- Equipment type videos demonstrating the proper operating of machinery and tools
- Industrial examples demonstrating practical applications of specific processes and skills
- Case oriented videos offering visual examples acting as introduction to the instruction of a topic or as practical confirmation of theoretical teaching
- Action videos demonstrating behavior, i.e. how to do or not to do a working process
- Video tours displaying overviews of working processes or construction of complex working machines that are put together by a

large number of small components – each requiring a significant amount of knowledge and work

- Conceptual videos mediating theoretical results such that professionals, suffering from dyslexia, don’t need to obtain knowledge just by reading and understanding complex text based documents

The learning material may also contain online data like notes and PowerPoint presentations that have been tracked from Smartboard sessions. They may be uploaded into the Learning Management System immediately after a video training session. Practical training is held in laboratory or in the workshop, and may when needed be supported with video clips from the theoretical curriculum.

Effective solutions for know-how transfer

Training offered in combination with job and industrial production activities, is one of the best available training methods since it is planned, organized, and conducted at the employee's worksite. Such training will generally be the primary method used for broadening employee skills and increasing productivity. The combination of ABT, easy access to various classes of video resources (Stav 2007) and inclusion of blended learning methodologies validate a new generation of training and educational activities. It offers the teachers, as well as the students, figure 3, access to new training environments compared with what is frequently used today in SME.

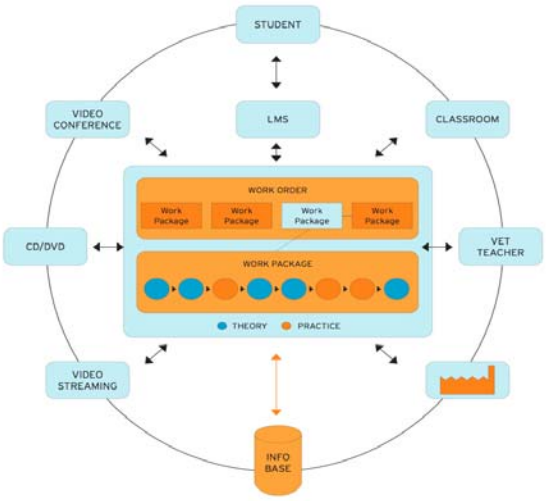

Figure 3: The Activity Based Training environment utilizes work orders and work packages, in combination with on-site training, Learning Management Systems (LMS), video streaming and videoconferencing. The info base offers on-line access to best practices and state of the art video communication.

The outsourcing process will usually involve transfer of various types of technical information and know-how to different user groups. Oral communication is fast, effective, and may leads to quick results without any risks for misunderstandings or misinterpretations since issues related to the semantic interoperability within technical communication may be addressed immediately during the ongoing discussion. Unfortunately, oral communication traditionally takes

place face-to-face. Oral communication processes may be offered efficiently at distance by mixing state of the art high quality videoconferencing solutions with digital backboards. In such a setting two video streams are transferred in parallel, one containing the instructor and the second one the presentation the instructor make up on the digital blackboard.

The instructor may in real time, as shown in Figure 4, make up notes, remarks and annotations on the Smartboard, while he/she discuss details related to welding specifications and welding procedures with the personnel at the remote site (e.g. a company receiving an outsourced production). The instructor may watch the personnel at the remote site on one of his monitors during the verification of the production process knowledge. The personnel may at the same time look at the instructor and the notes he/she makes on the Smartboard on two screens. The staff may in real time ask questions and discuss practical issues related to the production process. Two monitors are used for small groups of personnel, while two large screens are used large group of staff.

This system solution may be used for easy; flexible, ongoing verbal and visual verification of mechanical industry production process knowledge that require detailed technical communication processes to wide user groups inside a company. This includes defining possible problem areas, verification of the existing and required competence levels, identification of possible competence gaps, continuous development of methods for corrective actions, etc.

Figure 4: Use of videoconferencing (H.264) and digital blackboards for just-in-time transfer of know-how and competence. The left picture shows how the instructor uses a Smartboard to mediate details in a welding production process. The right one displays the results to a group of personnel at the end-user site.

Conclusions

This paper presented new Activity Based Training (ABT) methodologies for efficient know-how transfer in the context of global production processes that takes advantage of the latest technology advances in the area of networking and visual communications. The principles for ABT focus on delivering theoretical content when it is needed just in front of the practical training tasks, linking directly theory and practice in order to create relevance and motivate the student, triggering ultimately reflective cognition processes. Such knowledge transfer is particular important within global production environments where it is necessary to transfer mechanical industrial company specific know-how and competence across large distances, often on a just-in-time basis, due to tight production constraints.

The methodologies discussed in the paper are applicable both towards formal training and informal skill transfer and may act as complementary skill development processes to the formal VET training system. The selected pedagogical framework is closely connected to the production workflow through learning resources utilizing orders, each containing a number of work packages.

The methodologies are under validation in real-life conditions involving European companies across borders active in the welding sector as well as standards organizations including the European Welding Federation, the Institut za Varilstvo in Slovenia, and the Polish Centre of Welding Technology. However, they are adaptable and applicable in the wider manufacturing sector.

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